EXHIBIT A

Support for Claims 40, 42-43, 47, 51-64

Reproduced below, are portions of the specification of U.S.S.N. 09/833,016 (the "'016 Application") that are examples of support in the '016 Application for each limitation of Claims 40, 42-43, 47, 51-64 delineated below. This list is not intended to be exhaustive.

I. Support for Claim 40

A. ***A method for designing a roller cone bit, comprising:***

1. Design of A Force Balanced Roller Cone Bit. *See '016 Application, Page 16, line 11.*

2. According to another disclosed class of innovative embodiments, there is provided: A method of designing a roller cone drill bit... *See '016 Application, Page 22, lines 1-3.*

B. ***simulating the drill bit drilling through an earth formation, the simulating comprising:***

1. After having the single element force model, the next step is to determine the interaction between inserts and the formation drilled. This step involves the determination of the tooth kinematics (local) from the bit and cone kinematics (global) as described below.

(1) The bit kinematics is described by bit rotation speed, Ω=RPM (revolutions per minute), and the rate of penetration, ROP. Both RPM and ROP may be considered as constant or as function with time.

(2) The cone kinematics is described by cone rotational speed. Each cone may have its own speed. The initial value is calculated from the bit geometric parameters or just estimated from experiment. In the calculation the cone speed may be changed based on the torque acting on the cone.

(3) At the initial time, t0, the hole bottom is considered as a plane and is meshed into small grids. The tooth is also meshed into grids (single elements). At any time t, the position of a tooth in space is fully determined. If the tooth is in interaction with the hole bottom, the hole bottom is updated and the cutting depth for each cutting element is calculated and the forces acting on the elements are obtained.

(4) The element forces are integrated into tooth forces, the tooth forces are integrated into cone forces, the cone forces are transferred into bearing forces and the bearing forces are integrated into bit forces.

(5) After the bit is fully drilled into the rock, these forces are recorded at each time step. A period time usually at least 10 seconds is simulated. The average forces may be considered as static forces and are used for evaluation of the balance condition of the cutting structure. *See '016 Application, Page 14, line 6 to Page 15, Line 3.*

2. V_{3d0} is obtained from the rock bit computer program by simulate the bit drilling procedure at least 10 seconds. *See '016 Application, Page 17, lines 26-27.*

C. ***determining, based on a means for determining an axial force, an axial force acting on each of the cutting elements,***

1. Looking at FIG. 1, each tooth, shown on the right side, can be thought of as composed of a collection of elements, such as are shown on the left side. Each element

used in the present invention has a square cross section with area S_e (its cross-section on the x-y plane) and length L_e (along the z axis). The force-cutting relationship for this single element may be described by:

$$F_{ze} = K_e * \sigma * S_e \quad (1)$$
$$F_{xe} = \mu_x * F_{ze} \quad (2)$$
$$F_{ye} = \mu_y * F_{ze} \quad (3)$$

where F_{ze} is the normal force and F_{xe}, F_{ye} are side forces, respectively, σ is the compressive strength, S_e the cutting depth and K_e, μ_x and μ_y are coefficient associated with formation properties. These coefficients may be determined by lab test. A tooth or an insert can always be divided into several elements. Therefore, the total force on a tooth can be obtained by integrating equation (1) to (3). *See '016 Application, Page 13, lines 8-23.*

2. (3) At the initial time, t0, the hole bottom is considered as a plane and is meshed into small grids. The tooth is also meshed into grids (single elements). At any time t, the position of a tooth in space is fully determined. If the tooth is in interaction with the hole bottom, the hole bottom is updated and the cutting depth for each cutting element is calculated and the forces acting on the elements are obtained.

(4) The element forces are integrated into tooth forces... *See '016 Application, Page 14, lines 19-26.*

3. (a) calculating the axial force acting on each tooth on each cutting structure... *See '016 Application, Page 22, lines 3-4.*

D. ***determining the axial force acting on each of the roller cones, based on the axial force acting on the cutting elements,***

1. (4) The element forces are integrated into tooth forces, the tooth forces are integrated into cone forces... *See '016 Application, Page 14, lines 26-27.*

2. (b) calculating the axial force acting on each cutting structure per revolution of the drill bit... *See '016 Application, Page 22, lines 4-5.*

E. ***rotating the bit and redetermining the axial forces acting on each of the cutting elements,***

1. (3) At the initial time, t0, the hole bottom is considered as a plane and is meshed into small grids. The tooth is also meshed into grids (single elements). At any time t, the position of a tooth in space is fully determined. If the tooth is in interaction with the hole bottom, the hole bottom is updated and the cutting depth for each cutting element is calculated and the forces acting on the elements are obtained. *See '016 Application, Page 14, lines 19-25.*

2. (5) After the bit is fully drilled into the rock, these forces are recorded at each time step. A period time usually at least 10 seconds is simulated. *See '016 Application, Page 14, line 28 to Page 15, Line 2.*

3. (a) calculating the axial force acting on each tooth on each cutting structure; (b) calculating the axial force acting on each cutting structure per revolution of the drill bit; (c) comparing the axial force acting on each of said cutting structures with the axial force on the other ones of said cutting structures of the bit; (d) adjusting at least one geometric parameter on the design of at least one cutting structure; (e) repeating steps (a)

through (d) until approximately the same axial force is acting on each cutting structure. *See '016 Application, Page 22, lines 3-10.*

F. ***repeating the rotating and redetermining for a number of rotations, and***

1. (3) At the initial time, t0, the hole bottom is considered as a plane and is meshed into small grids. The tooth is also meshed into grids (single elements). At any time t, the position of a tooth in space is fully determined. If the tooth is in interaction with the hole bottom, the hole bottom is updated and the cutting depth for each cutting element is calculated and the forces acting on the elements are obtained. *See '016 Application, Page 14, lines 19-25.*

2. (5) After the bit is fully drilled into the rock, these forces are recorded at each time step. A period time usually at least 10 seconds is simulated. *See '016 Application, Page 14, line 28 to Page 15, Line 2.*

3. V_{3d0} is obtained from the rock bit computer program by simulate the bit drilling procedure at least 10 seconds. *See '016 Application, Page 17, lines 26-27.*

4. (a) calculating the axial force acting on each tooth on each cutting structure; (b) calculating the axial force acting on each cutting structure per revolution of the drill bit; (c) comparing the axial force acting on each of said cutting structures with the axial force on the other ones of said cutting structures of the bit; (d) adjusting at least one geometric parameter on the design of at least one cutting structure; (e) repeating steps (a) through (d) until approximately the same axial force is acting on each cutting structure. *See '016 Application, Page 22, lines 3-10.*

G. ***adjusting at least one bit design parameter, and repeating the simulating and adjusting until a difference between the axial force on each one of the roller cones is less than a difference between the axial force determined prior to adjusting the at least one initial design parameter.***

1. (5) After the bit is fully drilled into the rock, these forces are recorded at each time step. A period time usually at least 10 seconds is simulated. The average forces may be considered as static forces and are used for evaluation of the balance condition of the cutting structure. *See '016 Application, Page 14, line 28 to Page 15, Line 3.*

2. If the forces are not balanced, then the optimization must occur. Objectives, constraints, design variables and their bounds (maximum and minimum allowed values) are defined, and the variables are altered to conform to the new objectives. Once the new objectives are met, the new geometric parameters are used to redesign the bit, and the forces are again calculated and checked for balance. This process is repeated until the desired force balance is achieved. *See '016 Application, Page 19, lines 15-21.*

3. (a) calculating the axial force acting on each tooth on each cutting structure; (b) calculating the axial force acting on each cutting structure per revolution of the drill bit; (c) comparing the axial force acting on each of said cutting structures with the axial force on the other ones of said cutting structures of the bit; (d) adjusting at least one geometric parameter on the design of at least one cutting structure; (e) repeating steps (a) through (d) until approximately the same axial force is acting on each cutting structure. *See '016 Application, Page 22, lines 3-10.*

II. Support for Claim 42

A. ***The method as defined in claim 40 wherein adjusting comprises changing a number of cutting elements on at least one of the cones.***

1. As we stated in previous sections, there are many parameters which affect bit balance conditions. Among these parameters, the teeth crest length, their positions on cones (row distribution on cone) and the number of teeth play a significant role. *See '016 Application, Page 16, lines 12-15.*

2. In reality, the removed volume by each row depends not only on the above design variables, but also on the number of teeth on that row and the tracking condition. *See '016 Application, Page 17, lines 19-21.*

III. Support for Claim 43

A. ***The method as defined in claim 40, wherein adjusting comprises changing a location of cutting elements on at least one of the cones.***

1. See Paragraph II(A)(1) above. *See '016 Application, Page 16, lines 12-15.*

IV. Support for Claim 47

A. ***A method for designing a roller cone drill bit, comprising:***

1. See Paragraphs I(A)(1-2) above. *See '016 Application, Page 16, line 11; Page 22, lines 1-3.*

B. ***simulating the bit drilling through an earth formation wherein the simulating comprises determining an axial force on a cutting element based on a means for determining an axial force, determining an axial force on the roller cones, based on the axial forces on the cutting elements, and angularly rotating the bit;***

1. See Paragraph I(C)(1) above. *See '016 Application, Page 13, lines 8-23.*

2. See Paragraph I(B)(1-2) above. *See '016 Application, Page 14, line 6 to Page 15, Line 3; Page 17, lines 26-27.*

3. See Paragraph I(E)(3) above. *See '016 Application, Page 22, lines 3-10.*

C. ***adjusting at least one design parameter of the bit;***

1. See Paragraph I(G)(2) above. *See '016 Application, Page 19, lines 15-21.*

2. (d) adjusting at least one geometric parameter on the design of at least one cutting structure... *See '016 Application, Page 22, lines 7-8.*

D. ***repeating the simulating the bit drilling; and***

1. See Paragraphs I(F)(1-4) above. *See '016 Application, Page 14, lines 19-25; Page 14, line 28 to Page 15, Line 2; Page 17, lines 26-27; Page 22, lines 3-10.*

E. ***comparing a distribution of axial forces among the roller cones prior to the adjusting the at least one design parameter with a distribution of axial forces among the roller cones after adjusting the at least one design parameter.***

1. See Paragraphs I(G)(1-3) above. *See '016 Application, Page 14, line 28 to Page 15, Line 3; Page 19, lines 15-21; Page 22, lines 3-10.*

V. Support for Claim 51

A. ***The method of claim 47, wherein the adjusting comprises changing an orientation of at least one cutting element.***

1. Therefore the only design variables for a row are the crest length, Lc, the radial position of the center of the crest length, Rc, and the tooth angles, α and β. *See '016 Application, Page 16, lines 24-26.*

VI. Support for Claim 52

A. ***The method of claim 47, wherein a designer compares the distribution of axial forces.***

1. Designer can evaluate the force balance and energy balance conditions of existing bit designs. Designer can design force balanced drill bits with predictable bottom hole patterns without relying on lab tests followed by design modifications. Designer can optimize the design of roller cone drill bits within designer-chosen constraints. *See '016 Application, Page 11, lines 8-14.*

VII. Support for Claim 53

A. ***The method of claim 40, wherein adjusting comprises changing an orientation of at least one cutting element.***

1. See Paragraphs VI(A)(1) above. *See '016 Application, Page 16, lines 24-26.*

VIII. Support for Claim 54

A. ***The method of claim 40, wherein the adjusting and the repeating are continued until a distribution of axial force is substantially balanced between the roller cones.***

1. See Paragraphs I(G)(3) above. *See '016 Application, Page 22, lines 3-10.*

IX. Support for Claim 55

A. ***A method for designing a roller cone bit, comprising:***

1. See Paragraphs I(A)(1-2) above. *See '016 Application, Page 16, line 11; Page 22, lines 1-3.*

B. ***simulating the drill bit drilling through an earth formation, the simulating comprising:***

1. See Paragraph I(B)(1-2) above. *See '016 Application, Page 14, line 6 to Page 15, Line 3; Page 17, lines 26-27.*

C. ***obtaining an axial force acting on each of the cutting elements,***

1. See Paragraph I(C)(1-3) above. *See '016 Application, Page 13, lines 8-23; Page 14, lines 19-26; Page 22, lines 3-4.*

D. ***determining the axial force acting on each of the roller cones, based on the axial force acting on the cutting elements,***

1. See Paragraph I(D)(1-2) above. *See '016 Application, Page 14, lines 26-27; Page 22, lines 4-5.*

E. ***angularly rotating the bit and reobtaining the axial forces acting on each of the cutting elements, and repeating the rotating and reobtaining for a number of rotations; and***

1. See Paragraph I(F)(1-2, 4) above. *See '016 Application, Page 14, lines 19-25; Page 14, line 28 to Page 15, Line 2; Page 22, lines 3-10.*

F. ***adjusting at least one bit design parameter, and***

1. See Paragraph I(G)(2) above. *See '016 Application, Page 19, lines 15-21.*

2. See Paragraph IV(C)(2) above. *See '016 Application, Page 22, lines 7-8.*

G. ***repeating the simulating and adjusting until a difference between the axial force on each one of the roller cones is less than a difference between the axial force determined prior to adjusting the at least one bit design parameter.***

1. See Paragraphs I(G)(1-3) above. *See '016 Application, Page 14, line 28 to Page 15, Line 3; Page 19, lines 15-21; Page 22, lines 3-10.*

X. Support for Claim 56

A. ***The method of claim 55, wherein adjusting comprises changing an orientation of at least one cutting element.***

1. See Paragraphs VI(A)(1) above. *See '016 Application, Page 16, lines 24-26.*

XI. Support for Claim 57

A. ***The method of claim 55, wherein the adjusting and the repeating are continued until a distribution of axial force is substantially balanced between the roller cones.***

1. See Paragraphs I(G)(3) above. *See '016 Application, Page 22, lines 3-10.*

XII. Support for Claim 58

A. ***A method for designing a roller cone bit, comprising:***

1. See Paragraphs I(A)(1-2) above. *See '016 Application, Page 16, line 11; Page 22, lines 1-3.*

B. ***simulating the drill bit drilling through an earth formation, the simulating comprising determining, based on a means for determining an axial force, an axial force acting on each of the cutting elements, and determining the axial force acting on each one of the roller cones, based on the axial force acting on the cutting elements, angularly***

rotating the bit and redetermining the axial forces acting on each of the cutting elements and redetermining the axial force acting on each one of the roller cones;

1. See Paragraph I(C)(1) above. *See '016 Application, Page 13, lines 8-23.*

2. See Paragraph I(B)(1-2) above. *See '016 Application, Page 14, line 6 to Page 15, Line 3; Page 17, lines 26-27.*

3. See Paragraph I(E)(3) above. *See '016 Application, Page 22, lines 3-10.*

C. ***repeating the rotating and redetermining for a number of rotations; and***

1. See Paragraphs I(F)(1-4) above. *See '016 Application, Page 14, lines 19-25; Page 14, line 28 to Page 15, Line 2; Page 17, lines 26-27; Page 22, lines 3-10.*

D. ***adjusting at least one bit design parameter, and***

1. See Paragraph I(G)(2) above. *See '016 Application, Page 19, lines 15-21.*

2. See Paragraph IV(C)(2) above. *See '016 Application, Page 22, lines 7-8.*

E. ***repeating the simulating and adjusting until a difference between the axial force on each one of the roller cones is less than a difference between the axial force determined prior to adjusting the at least one initial design parameter.***

1. See Paragraphs I(G)(1-3) above. *See '016 Application, Page 14, line 28 to Page 15, Line 3; Page 19, lines 15-21; Page 22, lines 3-10.*

XIII. Support for Claim 59

A. ***The method of claim 58, wherein adjusting comprises changing an orientation of at least one cutting element.***

1. See Paragraphs VI(A)(1) above. *See '016 Application, Page 16, lines 24-26.*

XIV. Support for Claim 60

A. ***The method of claim 58, wherein the adjusting and the repeating are continued until a distribution of axial force is substantially balanced between the roller cones.***

1. See Paragraphs I(G)(3) above. *See '016 Application, Page 22, lines 3-10.*

XV. Support for Claim 61

A. ***A method for designing a roller cone bit, comprising:***

1. See Paragraphs I(A)(1-2) above. *See '016 Application, Page 16, line 11; Page 22, lines 1-3.*

B. ***simulating the drill bit drilling through an earth formation, the simulating comprising:***

1. See Paragraph I(B)(1-2) above. *See '016 Application, Page 14, line 6 to Page 15, Line 3; Page 17, lines 26-27.*

C. ***obtaining an axial force acting on each of the cutting elements,***

1. See Paragraph I(C)(1-3) above. *See '016 Application, Page 13, lines 8-23; Page 14, lines 19-26; Page 22, lines 3-4.*

D. ***obtaining the axial force acting on the cutting elements on each one of the roller cones, based on the axial forces acting on the cutting elements,***

1. See Paragraph I(D)(1-2) above. *See '016 Application, Page 14, lines 26-27; Page 22, lines 4-5.*

E. ***angularly rotating the bit and reobtaining the axial forces acting on each of the cutting elements,***

1. See Paragraph I(F)(1-2, 4) above. *See '016 Application, Page 14, lines 19-25; Page 14, line 28 to Page 15, Line 2; Page 22, lines 3-10.*

F. ***repeating the rotating and reobtaining for a number of rotations, and***

1. See Paragraphs I(F)(1-4) above. *See '016 Application, Page 14, lines 19-25; Page 14, line 28 to Page 15, Line 2; Page 17, lines 26-27; Page 22, lines 3-10.*

G. ***adjusting at least one bit design parameter, and repeating the simulating and adjusting until a rate of penetration on the bit is increased in comparison to a first simulation of the drill bit.***

1. See Paragraphs I(G)(1-3) above. *See '016 Application, Page 14, line 28 to Page 15, Line 3; Page 19, lines 15-21; Page 22, lines 3-10.*

2. The economics of drilling a well are strongly reliant on rate of penetration. Since the design of the cutting structure of a drill bit controls the bit's ability to achieve a high rate of penetration, cutting structure design plays a significant role in the overall economics of drilling a well. *See '016 Application, Page 6, lines 10-14.*

3. However for the bit manufacturer or bit designer it is necessary to know the teeth orientation angle on the cone coordinate, in order either to keep the elongate side of the tooth perpendicular to the scraping direction (for maximum cutting rate in softer formations) or to keep the elongate side of the tooth in line with the scraping direction (for durability in harder formations). *See '016 Application, Page 11, lines 19-28 (Incorporating by reference text of U.S. Patent Number 6,095,262, Column 9, Lines 53-60).*

XVI. Support for Claim 62

A. ***A new method for designing a roller cone drill bit, comprising:***

1. See Paragraphs I(A)(1-2) above. *See '016 Application, Page 16, line 11; Page 22, lines 1-3.*

B. ***simulating the bit drilling through an earth formation, wherein the simulating comprises obtaining an axial force on a cutting element, determining the axial force acting on each one of the roller cones, based on the axial forces acting on the cutting elements, and angularly rotating the bit;***

1. See Paragraph I(C)(1) above. *See '016 Application, Page 13, lines 8-23.*

2. See Paragraph I(B)(1-2) above. *See '016 Application, Page 14, line 6 to Page 15, Line 3; Page 17, lines 26-27.*

3. See Paragraph I(E)(3) above. *See '016 Application, Page 22, lines 3-10.*

C. ***adjusting at least one design parameter of the bit;***

1. See Paragraph I(G)(2) above. *See '016 Application, Page 19, lines 15-21.*

2. See Paragraph IV(C)(2) above. *See '016 Application, Page 22, lines 7-8.*

D. ***repeating the simulating the bit drilling; and***

1. See Paragraphs I(F)(1-4) above. *See '016 Application, Page 14, lines 19-25; Page 14, line 28 to Page 15, Line 2; Page 17, lines 26-27; Page 22, lines 3-10.*

E. ***comparing a distribution of axial forces acting on the roller cones prior to the adjusting with a distribution of axial forces acting on the roller cones after adjusting.***

1. See Paragraphs I(G)(1-3) above. *See '016 Application, Page 14, line 28 to Page 15, Line 3; Page 19, lines 15-21; Page 22, lines 3-10.*

XVII. Support for Claim 63

A. ***The method of claim 62, wherein adjusting comprises changing an orientation of at least one cutting element.***

1. See Paragraphs VI(A)(1) above. *See '016 Application, Page 16, lines 24-26.*

XVIII. Support for Claim 64

A. ***The method of claim 62, wherein a designer compares the axial forces.***

1. See Paragraphs VII(A)(1) above. *See '016 Application, Page 11, lines 8-14.*